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VERBAL WORKING MEMORY IN TYPICAL CHILDREN

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INTRODUCTION

According to Merriam Webster (1829) "Memory involves storing, focusing, attention on, and manipulating information for a relatively short period of time".A simple activity involving working memory is the carry-over operation in mental arithmetic, which requires temporarily storing a string of numbers and holding the sum of one addition in mind while calculating the next (Patricia S. Goldman-Rakic 1992).

Working memory is a cognitive system with a finite capacity for temporarily storing information. Working memory is critical for reasoning, decision-making, and behavior guiding. Although working memory and short-term memory are often used interchangeably, some theorists believe the two types of memory are distinct, believing that working memory allows for the manipulation of stored information while short-term memory only allows for the storage of information for a short period of time. Working memory is a concept that is essential for cognitive psychology, neuropsychology, and neuroscience theory.

Working memory is used to store knowledge temporarily in order to direct ongoing cognitive operations. Working memory models have been proposed that vary greatly in their specificity and extent (Unsworth and Engle, 2007; Cowan, 2010; Oberauer, Lewandowsky, Farrell, Jarrold, and Greaves, 2012). Baddeley's multi-component model first proposed by Baddeley and Hitch (1974) and later refined by Baddeley (2000) has shown to be a particularly useful framework for describing the development of working memory in children (Bayliss, Jarrold, Baddeley, Gunn and Leigh, 2005; Alloway, Gathercole and Pickering, 2006 ; Henry, 2011).Working memory is important for reasoning, learning and comprehension.

Working memory is split up into three parts: The phonological loop, the visuo-spatial sketchpad and the central executive.

Verbal working memory plays an important role in reading comprehension and, for younger children, in the development of decoding skills to create reading fluency. It is a measure of the capacity of individuals to hold information in mind with the purpose of completing a task and helps them to remember the rules within a game or task.

Individuals often use rehearsal strategies such as repeating things in order to buffet their memory strategy skills. Verbal working memory involves the ability to remember something and to perform an activity using this memory. This skill allows us to maintain information in mind so that we can use it for learning, reasoning, or producing a result.

Working memory assists with daily tasks such as driving, writing essays, studying for exam, and various others. Working memory is more immediate, and reflects our ability to temporarily hold vital information 'online' for processing - such as dialing a new telephone number or recalling where you might have just placed your pen.It's been linked to intellect, information processing, executive function, understanding, problem-solving, and learning in people of all ages and animals. This type of memory is also important for everyday reasoning and decision making.

Goff, Pratt and Ong (2005) investigated the strongest independent predictors of reading comprehension using word reading, language and memory variables in a normal sample of 180 children in grades 3–5 with a range of word reading skills and concluded that that tasks measuring the interplay between short-term and long-term memory, in which new information is combined with information already stored in long-term memory, may better predict reading comprehension measured with the text available than working memory tasks which only have a short-term memory component.

Arnold and Evans (2005) studied the differences in strength of linguistic representations in the form of word frequency affect list recall and performance on verbal working memory tasks. And result showed that working memory capacity is not distinct from language knowledge and that degraded linguistic representations may have an effect on performance on verbal working memory span tasks in children with SLI.

Iyer and Venkatesan (2021) conducted studied on the urban Indian metropolitansbilinguals who have cognitive gains, trilingual children and their cognitive gains. A sample of 55 children aged 6 to 8 years, with 27 in bilingual and 28 in trilingual groups, and concluded that working memory performance is better in bilingual children of the present study in comparison to trilingual children. Indian studies are needed to implore these results with a better design and analysis.

Working Memory provides a mental workspace for tasks requiring both processing and storage. Working memory is a cognitive system whose essential function is to facilitate and beautify the potential of encoding, storage, and retrieval functions that are imperative for gaining knowledge and processing of facts. This study contributes to the literature on verbal working memory by reporting data on three verbal fluency tasks between two different age groups. This study shows that verbal working memory increases with the increase in age of children.

REVIEW OF LITERATURE

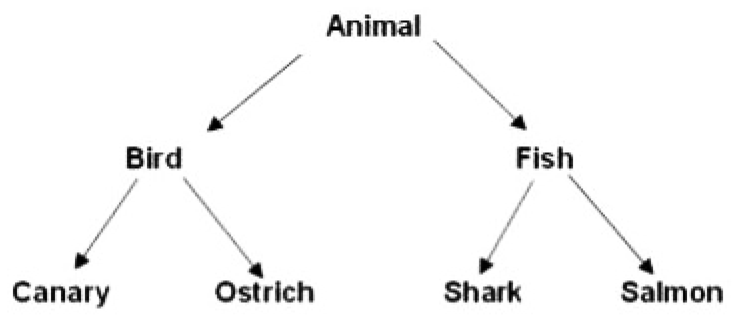
There are several ways in which the meaning of words may be related. Words do not have meanings in isolation; instead, the meaning of a word is usually related in important ways to the meanings of the words. Some of the most prominent of these relations in meaning are known collectively as sense relations, and there are several kinds.

Semantics and its representation

Semantics is the study of the meaning of linguistic expressions. Each word has a particular semantic field. The meaning of the words (and the concepts attached to the words) are organized hierarchically. For instance, canary is a bird, and a bird is an animal; but there are other birds, and there are other animals.

Figure 2.1:

Shows the hierarchical organization of words and concepts.



Semantic Relationships at Word Level

Semantic relationships are the associations that exist between the meanings of words (semantic relationships at word level), between the meanings of phrases, or between the meanings of sentences (semantic relationships at phrase or sentence level).

There are several kinds of sense relations as a result of the semantic relatedness between the form and meaning and between two meanings, they are:

Synonymy

Synonymy is the semantic relationship that exists between two (or more) words that have the same (or nearly the same) meaning and belong to the same part of speech, but are spelled differently. Synonyms are words with the same or similar meanings or are said to be synonymous. Examples of synonyms are, Big = large, Small = little. Pairs of words that are synonymous are believed to share all (or almost all) their semantic features or properties. However, no two words have exactly the same meaning in all the contexts in which they can occur.

Antonym

Antonyms are the word relationship that exists between two (or more) words that have opposite meanings. The pairs of words which have opposite meanings are called antonyms. Antonymous pairs of words usually belong to the same grammatical category (i.e., both elements are nouns, or both are adjectives, or both are verbs, and so on). They are said to share almost all their semantic features except one. The semantic feature that they do not share is present in one member of the pair and absent in the other.

Hyponymy

Hyponymy is the state or phenomenon that shows the relations between more general term (lexical representation) and the more specific instances of it. The concrete forms of sets of word (the specific instances) are called ‘hyponyms’.

Example: The lexical representation of: red, yellow, green, purple, black, is color. Thus, we can say that: “red is a hyponym of color”, and so on.

Homophony

When two or more different written forms have the same pronunciation, they are described as “Homophones”. For example: Bare – Bear, Meat – Meet, Flour – Flower. The term homonym is used when one form written or spoken has two or more unrelated meanings. For example: 1- bank= (of a river) bank= (financial institution).

Polysemy

If a word has multiple meanings, that is called polysemic. Relatedness of meaning accompanying identical form is technically known as polysemy. For example: The word “head” is used to refer to the object on the top of our body, on top of a glass of beer, on top of a company or department. Another word “foot” has multiple meanings such as foot of a person, of bed, of mountain etc.

Metonymy

There is another type of relationship between words based simply on a close connection in everyday experience. That close connection can be based on a container-contents relation (bottle- coke; can- juice), a whole- part relation (car- wheels; house-roof) or a representative- symbol relationship (king- crown; The President- The White House).

Collocation

Frequently occurring together is known as collocation. Words tend to occur with other words. For example: If you ask a thousand people what they think when you say ‘hammer’, more than half will say ‘nail’, if you say ‘table’ they will mostly say ‘chair’ and for ‘butter- bread, for needle- thread, for salt- pepper. Some collocations are joined pairs of words such as salt and pepper or husband and wife.

Working memory is the retention of a small amount of information in a readily accessible form. It facilitates planning, comprehension, reasoning, and problem-solving. Working memory is the small amount of information that can be held in mind and used in the execution of cognitive tasks, in contrast with long-term memory, the vast amount of information saved in one's life.

Components of working memory

1) Phonological loop
2) Episodic buffer
3) Visuo-spatial pad

Central Executive

Directs attention to particular task. It control the other systems by determining how resources will be allocated. (Think a control tower at an airport).

Phonological loop

Controls auditory information further subdivided into the phonological store (inner ear) and articulatory process (inner voice). The phonological loop is composed of two components, the phonological store and articulatory rehearsal process. Articulatory rehearsal process is accountable for rehearsing information to keep stored in the phonological store to prevent from forgetting. The phonological loop is responsible for auditory manipulation based on information. An Example would be to continuously repeat out loud or in your head a group of numbers, letters, or words to train your mind to remember them.

Visuo-spatial pad

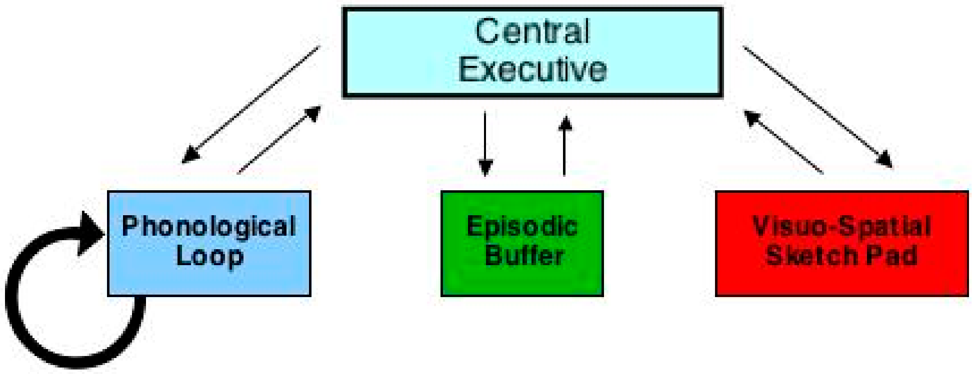
Processes visual and spatial information (how things look and where they are).

Episodic buffer

A limited capacity storage system responsible for integrating information from several sources to create a unified memory.

Figure 2.2:

Components of working memory



The basic premise of sensori-motor recruitment models of working memory is that the systems and representations engaged to perceive information can also contribute to the short-term retention of that information. For other domains of sensory information, such as visually perceived spatial frequency, contrast, orientation, behavioral evidence indicates that each is retained in a highly stimulus-specific manner (Magnussen 2000, Magnussen & Greenlee 1999, Zaksas, Bisley, Pasternak 2001) that is most parsimoniously explained as the persistent activation of the sensory representations themselves.

Verbal memory involves remembering words for the most part, but it does have other various elements to it as well, including the following:

- Language
- Verbal Items
- Recalling Words

Verbal memory is a form of short-term memory since it does hold the information in mind for a small amount of time. For example, you'll remember the grocery list that you have for this week, but next week you may not, since it's short term. That's because verbal memory involves three different elements, and they are as follows:

- *Capacity:* the amount of information that you can hold in it. Usually, its seven items give or take two of them.
- *Duration:* The amount of time that a person can hold memory in the short term verbal memory, usually about 15-30 seconds, with interruptions and delays messing with this, and potentially losing information.
- *Encoding:* a technique used to maintain the short-term verbal memory, and may include the repetition and rehearsal of memories. The number of items is referred to as miller's magic number, and this was found in 1956 when it was discovered that most adults could have 5-9 items within their short-term memory.

Neural correlates of working memory

Together with the Pre-frontal Cortex, parietal cortex is also strongly involved in working memory functioning. Superior parietal cortex has been associated with executive aspects of working memory (Collette, 2005; Koenigs, 2009). Basal ganglia, and more specifically striatal, involvement in working memory tasks is a relatively common finding in neuroimaging research (Wager and Smith, 2003) and are key structures in computational models (O'Reilly, 2006).

Western studies

Gathercole, Alloway, Willis and Adams (2006) investigated associations between working memory (measured by complex memory tasks) and both reading and mathematics abilities, as well as the possible mediating factors of fluid intelligence, verbal abilities, short-term memory (STM), and phonological awareness, in a sample of 46 6- to 11-year-olds with reading disabilities. The study suggested that working memory skills indexed by complex memory tasks represent an important constraint on the acquisition of skill and knowledge in reading and mathematics. Possible mechanisms for the contribution of working memory to learning, and the implications for educational practice, are considered.

Maehler and Schuchardt (2011) examined in three studies in which several functions of working memory according to Baddeley were explored. A working memory battery with tasks for the phonological loop, the visual–spatial sketchpad and central executive skills was presented in individual sessions to children with learning disabilities (dyslexia or dyscalculia or mixed disorders of scholastic skills) and normal IQ, to children with the same problems but lower IQ, and to control groups of children with regular school achievement and normal IQ and found that reveal specific deficits in working memory in the groups with learning disabilities compared with the control groups. However, there were no differences between the disabled groups with normal versus lower intelligence. These findings do not support the notion of discrepant cognitive functioning due to differences in intelligence of the groups, and therefore lead to doubts about the validity of the criterion of discrepancy.

Jonsdottir, Bouma, Sergeant and Scherder (2005) examined the impact of comorbid specific language impairment (SLI) on verbal and spatial working memory in children with DSM-IV combined subtype Attention Deficit Hyperactivity Disorder (ADHD-C). Participants were a clinical sample of 8½- to 12½-year-old children diagnosed with ADHD and with SLI and compared with ADHD without SLI and result show that working memory deficits are not a specific characteristic of ADHD but are associated with language impairments. The importance of screening for language disorders in studies of neuropsychological functioning in children with ADHD is emphasized.

Martinussen, Hayden, Johnson and Tannock (2005) determined the empirical evidence for deficits in working memory (WM) processes in children and adolescents with attention-deficit/hyperactivity disorder (ADHD) and concluded that WM impairments in children with ADHD supports recent theoretical models implicating WM processes in ADHD. Future research is needed to more clearly delineate the nature, severity, and specificity of the impairments to ADHD.

Maehler and Schuchartd (2016) studied the role of working memory for school achievement, especially for unexpected failure or success. And found that academic success can lead both to unexpected overachievement and failure at school. Individual working memory competencies should be taken into account with regard to diagnosis and intervention for children with learning problems.

Nittrouer, Tarr, Low and Lowenstein (2017) investigated verbal working memory in children with cochlear implants and children with normal hearing in with participants of 4th grade (47 with normal hearing, 46 with cochlear implants) and concluded that verbal working memory deficits of children with cochlear implants arise due to signal degradation, which limits their abilities to acquire phonological awareness. That hinders their abilities to store items using a phonological code.

Williams, Diane, Goldstein, Minshew and Nancy (2009) administered to 38 high-functioning children with autism and 38 individually matched normal controls, 8-16 years of age. The resulting profile of memory abilities in the children with autism was characterized by relatively poor memory for complex visual and verbal information and spatial working memory with relatively intact associative learning ability, verbal working memory, and recognition memory and suggested that the challenges presented by differences in memory functioning prevent children with autism from acquiring relevant information needed to negotiate their environment. Such differences also may limit their capacity to organize the massive amounts of information with which they are confronted, contributing to their being overwhelmed as the amount and complexity of information increases.

Vuontela, Carlson, Troberg, Fontell, Simola, Saarinen and Aronen (2012) investigated the development of executive functions (EFs) and their associations with performance and behavior at school in 8–12-year-old children. The EFs were measured by computer-based n-back, Continuous Performance and Go/Nogo tasks. School performance was evaluated by Teacher Report Form (TRF) and behavior by TRF and Child Behavior Checklist. The studied dimensions of EF were cognitive efficiency/speed, working memory/attention and inhibitory control and the result showed that maturational factors may underlie low adaptive functioning and psychiatric symptoms during early school years. Further studies are needed to evaluate the association between inhibition and emotional symptoms.

Korpela, Nyman, Munck, Ahtola, Matomaki, Korhonen, Parkkola and Haataja, (2016) studied the working memory (WM) of very-low-birthweight children at the age of 11 years using Baddeley's WM model and found that the (WM) working memory of the (VLBW) very-low-birthweight children in the study differ-especially in the CE and VS subtest scores-from the normative population irrespective of the degree of brain pathology and level of cognitive development.

Passolunghi and Costa (2014) studied to verify and compare the effects of two types of training on early numerical skills. One type of training focused on the enhancement of working memory, a domain-general precursor, while the other focused on the enhancement of early numeracy, a domain-specific precursor. The conclusion was that the early numeracy intervention specifically improved early numeracy abilities in preschool children, whereas working memory intervention improved not only working memory abilities but also early numeracy abilities.

Vaz, Cordeiro, Macedo and Lukasova (2010) evaluated the development of working memory along the first school grades of basic education and to verify the applicability of the Brown-Peterson Task in the assessment of this function in children. And found that working memory development continues during the basic education years, indicating late maturation of related brain areas. The Brown-Peterson Task proved to be an adequate tool for the assessment of working memory in children.

Soleymani, Amidfar, Dadgar and Jalaie (2014) investigated working memory as a cognition skill in children with normal development and cochlear implant. Fifty students with normal hearing and 50 students with cochlear implant aged 5-7 years were participated and concluded that children with cochlear implant may experience difficulties in working memory. Therefore, these children have problems in encoding, practicing, and repeating phonological units. The results also suggested working memory develops when the child grows up. In cochlear implant children, with decreasing age at implantation and increasing their experience in perceiving sound, working memory skills improved.

According to Neo-Piagetian theories of cognitive development Measures of performance on tests of working memory increase continuously between early childhood and adolescence, while the structure of correlations between different tests remains largely constant. Starting with work in the Neo-Piagetian tradition,theorists have argued that the growth of working-memory capacity is a major driving force of cognitive development. This hypothesis has received substantial empirical support from studies showing that the capacity of working memory is a strong predictor of cognitive abilities in childhood. Particularly strong evidence for a role of working memory for development comes from a longitudinal study showing that working-memory capacity at one age predicts reasoning ability at a later age. Studies in the Neo-Piagetian tradition have added to this picture by analyzing the complexity of cognitive tasks in terms of the number of items or relations that have to be considered simultaneously for a solution. Across a broad range of tasks, children manage task versions of the same level of complexity at about the same age, consistent with the view that working memory capacity limits the complexity they can handle at a given age. Although neuroscience studies support the notion that children rely on prefrontal cortex for performing various working memory tasks, an fMRI meta-analysis on children compared to adults performing the n back task revealed lack of consistent prefrontal cortex activation in children, while posterior regions including the insular cortex and cerebellum remain intact.

Indian studies

Roy, Swarna and Prabhu (2020) examined the difference in the auditory working memory of the children with abacus training and children without abacus training. The participants were divided based on those with and without abacus training between the age of 9-13 years. The children with the abacus training group were taking intensive abacus training in the range of 2-4 years. The results concluded superior auditory performance and enhanced auditory working memory in children with abacus training.

Kotnala and Halder (2018) studied to find out cognitive functioning: working memory, verbal comprehension, perceptual reasoning and processing speed among ADHD and comparing with normal children. Result found that children with ADHD have poor cognitive functioning compared to normal children.

Iyer and Venkatesan (2021) investigated the profile of working memory in children with neuro-developmental disorders against their matched, typically developing children all belonging to high socioeconomic status families. The study concluded that working memory differs significantly between children with neuro-developmental disorders and, typically developing children.

Need for the study

Working Memory provides a mental workspace for tasks requiring both processing and storage. Working memory is a cognitive system whose essential function is to facilitate and beautify the potential of encoding, storage, and retrieval functions that are imperative for gaining knowledge and processing of facts.

More uniquely human has the ability to represent concepts in the form of language, which allows not only the spread of conceptual knowledge in an abstract symbolic form, but also a cognitive mechanism for the fluid and flexible manipulation, association and combination of concepts.

Thus, humans use conceptual knowledge for much more than merely interacting with objects. All of human culture, including science, literature, social institutions, religion, and art, is constituted from conceptual knowledge. We do not reason, plan the future or remember the past without conceptual consent- all of these activities depend on activation of concepts stored in semantic memory.

Most studies predominantly analyze the patterns within and between the clusters. Very few studies have reported attempted to correlate the findings on verbal fluency tasks to the cognitive processes governing them.

This study contributes to the literature on verbal working memory by reporting data on three verbal fluency tasks between two different age groups. This study shows that verbal working memory increases with the increase in age of children.

METHOD

Aims and objectives of the study

The present study aims at investigating the differences in verbal working memory between two different age group children. The study objectives were the comparison of frequencies in verbal working memory tasks between two age groups.

Participants

For the current study, a purposive sample of normal children of two different age groups are collected.

The study includes total of 30 children. In which, Group 1 includes 15 children of the age 15 years and Group 2 includes 15 children of the age 8 years. The language used for data collection is English.

Instrumentation

For the recording of verbal responses, *Praat* software (Version: updated, 2013) will be used and analyzed using Goldwave Software. A stop watch id used for the scheduling of time. A time window of 60 seconds as response time is used in the study. Modified data analysis sheet was used for the purpose of analysis of various selected verbal fluency measures.

Working memory Measurement

All testing is conducted in English language and each participant is tested individually in a vacant room. Each participant performed three*semantic fluency* tasks. The subtasks considered for the study were:

Task 1: Semantic Category Fluency tasks – Animals

In *Semantic Fluency task*, the participants are given the task of generating lexical category of Animals.

Instruction for the task

"I want you to name as many names of the items belonging to a particular category as you can in 1 minute. It doesn't matter what letter they start with. You have to name all the animals you can think of in one minute”.

Task 2: Semantic Category Fluency tasks –Vegetables

In *Semantic Fluency task,* the participants are given the task of generating lexical category of Vegetables.

Instruction for the task

“I want you to name as many names of the items belonging to a particular category as you can in 1 minute. It doesn’t matter what letter they start with. You have to name all the Fruits and Vegetables you can think of in one minute”.

Task 3: Semantic Category Fluency tasks - Vehicles

In *Semantic Fluency task*, the participants are given the task of generating the names ofVehicles.

Instruction for the task

“I want you to name as many names of the items belonging to a particular category as you can in 1 minute. It doesn’t matter what letter they start with. You have to name all the Vehicles you can think of in one minute”.

These specific categories is chosen as it is concrete, rational, and familiar and known to the participants in the Indian context. Most of the studies have also reported of category fluency being dependent on regional, environmental and cultural differences (Brucki & Rocha, 2004; Kempler, Teng, Dick, Taussig and Davis., 1998).

The order of administration of verbal fluency task was constant across participants, within Semantic Verbal Fluency of Animals, Semantic verbal fluency of Fruits and Vegetables and Semantic verbal fluency of Vehicles.The total duration of testing is approximately 10 minutes per individuals.

The mean value of ‘animal category task’ is calculated among the 15 children, of group 1. Similarly, the mean values for the category of ‘vegetables’ and ‘vehicles’ are calculated.The same procedure is followed for the group 2.

Procedure

Each task of working memory was timed using a stopwatch. The examiner recorded the participant's responses in *Praat* Software. Using the *GoldWave* software the examiner documented the responses later into the recording form for further offline analysis. The analysis for the recorded verbal fluency was carried out.

Analysis of the data

The Total number of Correct Words produced during each type of fluency task was calculated by excluding.

a) Intrusions (words not an exemplar of the category specified).

b) Perseverations (repetitions of any correct words already given as a response).

c) Morphological variants (example: bus, buses).

d) Language variation (a word named in other languages after it has been named in some other language).

For the scoring purpose, the raw score of total number of correct words obtained was retained, instead of being converted to percentage scores. This was is done as the percentage of the correct words generated did not provide meaningful information on fluency performance, as compared to the reporting the raw number of words generated (Troyer, 2000). For example, if the child says "cat, dog, cow, buffalo, ox, cat, lion", the total number of correct words was considered as six.

Statistical Analysis

The mean values of the above mentioned verbal working memory measures is tabulated for the purpose of comparing the differences among the individuals in two groups.

Descriptive statistics for the data is obtained by using SPSS statistical program (IBM 20.0 version). Analysis of variance (ANOVA) test was carried out to document the mean and standard deviation.

A non-parametric 'Mann Whitney U' test was carried out and the statistical significance with values of < 0.05 were considered to be significantly different.

RESULTS AND DISCUSSION

The study was carried out between two groups of children (i.e group 1 consisted of children aged 15 years and group 2 consisted of children of 8 years of age) to profile their working memory abilities.

The primary objectives of the study were to document the frequency of verbal working memory for selected semantic fluency tasks for the lexical categories of 'animals', 'vegetables' and 'vehicles'.

The findings of the same are discussed under the following.

Frequency count

Semantic frequency count is a listing of the words of a language, with the several meanings of each word, and the relative frequency of occurrence of each meaning in general and/or specified contexts.

The total number of correct word produced during each types of fluency task was calculated by excluding

a) Intrusions (words not an exemplar of the category specified),
b) Perseverations (repetitions of any correct words already given as a response),
c) Morphological variants (example: bus, buses),
d) Language variation (a word names in other languages after it has been name in some other language).

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According to Studies done by Cohena, Morgan,Vaughn, Riccioc and Hall (1999), verbal fluency is not significantly associated with age in early through middle adulthood, but does decline with advancing age. In children, however, verbal fluency development has been found to be positively related to age. Some researchers have found that verbal fluency increases with age and approaches adult levels by age 10 (e.g., Regard, Strauss & Knapp 1982) whereas others (Welsh, Pennington & Groisser, 1991) have found that children as old as 12 were significantly less fluent than an adult group, suggesting that verbal fluency continues to develop into adolescence. This is consistent with research that has shown that frontal lobe functioning develops in multiple stages throughout childhood, with full mastery of all frontal lobe skills not present at 12 years of age (Becker, Isaac, Hynd1987 Passler, Isaac, Hynd 1985). Thus, verbal fluency measures may be sensitive to neurodevelopment, but it is not yet clear at what age performance on these instruments reaches adult levels.

Comparison between the groups

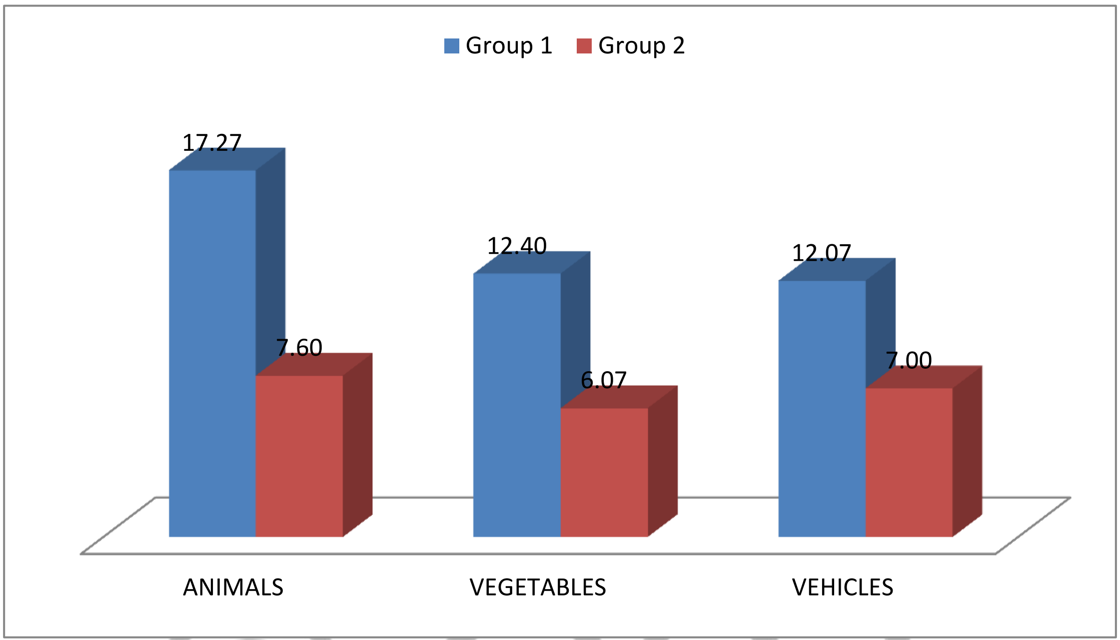
Table 4.1:

Showing Mean and SD scores of Frequency count for verbal working memory tasks forthe given groups

Types		N	Mean	Std. Deviation	95% Confidence Interval for Mean		t test p value	
					Lower Bound	Upper Bound		
ANIMALS	Group 1	15	17.27	5.60	14.17	20.37	0.000	HS
	Group 2	15	7.60	2.64	6.14	9.06		
	Total	30	12.43	6.53	9.99	14.87		
VEGETABLES	Group 1	15	12.40	3.33	10.55	14.25	0.000	HS
	Group 2	15	6.07	3.43	4.17	7.97		
	Total	30	9.23	4.63	7.50	10.96		
VEHICLES	Group 1	15	12.07	3.20	10.30	13.84	0.000	HS
	Group 2	15	7.00	2.90	5.39	8.61		
	Total	30	9.53	3.95	8.06	11.01		

Figure 4.1:

Showing Mean of Frequency Count for Verbal Working memory tasks in the given groups



From Table 4.1 and Fig 4.1 The frequency scores for the category tasks animal, vegetable and vehicles were lower for Group II (N=8)with the mean values of 7.6, 6.07 and 7 respectively. Whereas, the mean values of Group I (N=15) were 17.27, 12.4 and 12.07 for animal, vegetables and vehicles category respectively. The statistical analysis is suggestive of higher values for Group I and reveals High significant difference (with 'p' <0.05) for animal, vegetable and vehicle category.

For the older children the frequency count of verbal working memory for all the three categories were comparatively greater than that of younger children. The finding implies that the older children had better performance due to the advanced neurological development.

Differentiating between older and younger children using verbal working memory tasks reported that there was significant increase of reaction time in younger children. Due to the increase of the reaction time the rate of frequency decreases.

SUMMARY AND CONCLUSION

Working memory is responsible for many of the skills children used to learn to read. Auditory working memory helps kids hold on to the sounds letters make long enough to sound out new words. Visual working memory helps kids remember what those words look like so they can recognize them throughout the rest of a sentence. When working effectively, these skills keep kids from having to sound out every word they see. This helps them read with less hesitation and become fluent readers. Learning to read isn't as smooth a process for kids with weak working memory skills. Auditory working memory is the process of keeping sounds in mind for short periods of time when the sounds are no longer present in the environment.

According to the perspective of speech language pathologist verbal working memory tasks are one means of understanding how concept or word are organized in brain. Verbal working memory has been researched by several researchers and have been compared among normal children and children with neuro-developmental disorders. Many studies have concluded that the verbal working memory of typical children were better than that of children with neurological impairment.

Iyer and Venkatesan (2021) compared working memory in children with neuro developmental disorders to working memory in normally developing children all of whom come from high socioeconomic status. Working memory differs significantly between children with neuro developmental disorders and normally developing children. However, they have not found differences in working memory performance in the neuro-developmental disorders group.

A study done by Welsh, Pennington, and Groisser, (1991) concluded that verbal fluency measures may be sensitive to neuro-development, also that verbal fluency continues to develop into adolescence.This is consistent with research that has shown that frontal lobe functioning develops in multiple stages throughout childhood.

In the current studies the research question was to see for significant differences in VWM between the two groups of children. The present data provided evidence for the differences in WM between children of two different age groups. The participants were classified into two groups namely Group I with children of 15 years and Group II with children of 8 years. The verbal working memory paradigm involved word generation tasks of the three semantic fluency tasks (Animals, Vegetables and Vehicles). The responses were recorded using Praat software and responses were written into the recording form for further offline analysis. For each task, the outcome measures of the total number of correct words uttered were noted. The frequency count were tabulated and statistically analyzed. The study indicates the influence of the task and the difference in performance across the two age groups and to map the advancement of working memory with the increase in age.

The frequency score of 'Animals', 'Vegetables' and 'Vehicles' fluency tasks were better among the older children than the younger group. Although both the groups had Intrusions, Perseverations, Morphological variants, Language variation, the over-all performance of Group I was better than Group II.

To conclude the findings of the present study not only serves as a data for future studies on profiling the deviation of verbal working memory output among the different age groups, the study also provides an insight into the neuro-cognitive processes such as search, access and retrieval of information stored in the mental lexicon used by the participants. The results also revealed the factors which influenced their performance such as anxiety, culture, language and age. The findings show that the older children performed well, due to the development of the neural structures and their ability to sustain larger information. Hence, this study clearly gives an idea that Verbal Working Memory improves as a child grows, due to the development of the neural structures.

To summarize, the implications of this research study finding are

1) Better understanding of the neurological development
2) For the documentation of quantitative (total number of correct word production) performance of children of different age groups
3) To understand the usefulness of verbal working memory tasks.
4) Verbal working memory tasks are useful for Speech-Language Pathologist for assessing Pre and Post-therapy outcomes.

5) For expanding the clinical and research usefulness of verbal working memory task performance.

Limitations of the study and future recommendations

In the present study culture, mother tongue, gender, intelligence were not taken into consideration. The sample size was inadequate.

The future study would be more effective if culture, mother tongue, gender and intelligence is taken into consideration. The future research is indicated with the increased sample size.

REFERENCES

Alenka, R.C., Nestler E.J., and Hyman S.E. (2009). Higher cognitive function and behavioral control. *Foundation For Clinical Neuroscience,* 313-321. ISBN 978-0-07-148127-4.

Amand, M. (5) ways kids use working memory to learn. https://www.understood.org/articles/en/5-ways-kids-use-working-memory-to-learn.

Baddeley, A., and Hitch, G. (1974).Working memory. *Psychology of Learning and Motivation*, 8, 47–89. doi: 10.1016/j.cub.2009.12.014.

Claudia,M., and Kirsten,S. (2016). The importance of working memory for school achievementin primary school children with intellectual or learning disabilities. *Research in Developmental Disabilities,* 58, 1-8.doi.org/10.1016/j.ridd.2016.08.007.

Cowan and Nelson. (2008). What are the differences between long-term, short-term, and working memory. *Progress in Brain Research*, 169, 323–338. doi:10.1016/S0079-6123(07)00020-9.

Claudia, M., andKirsten, S. (2011). Working Memory in Children with Learning Disabilities: Rethinking the criterion of discrepancy. .*International Journal of Disability, Development and Education,* 58(1). doi.org/10.1080/1034912X.2011.547335.

Donald, H.S., Kristina, B., A. Lynne ,B., Susan, E.R., and Lawrence,G.W. (2019). WISC –Vand the Evolving Role of Intelligence Testing in the Assessment of Learning Disabilities. *Practical Resources for the Mental Health Professional*, 271-336. doi.org/10.1016/B978-0-12-815744-2.00009-4.

Daniel, J. A., andMaryellen, C.M. (2009). Verbal Working Memory and Language Production: Common Approaches to the Serial Ordering of Verbal Information. *Psychological Bulletin*, 135(1), 50–68. doi:10.1037/a0014411.

Deborah. A. G., Chris, P., andBen, O. (2005). The Relations Between Children's Reading Comprehension, Working Memory, Language Skills and Components of Reading Decoding in a Normal Sample.*Reading and writing,* 18, 583-616. doi.org/10.1007/s11145-004-7109-0.

Diamond, A. (2013). Executive functions. *Annual Review of Psychology,* 64, 135–168. doi:10.1146/annurev-psych-113011-143750.

Eva, K., Stijn, D. R., and Timothy, D. (2000). The Development of Working Memory: Exploring the Complementarity of Two Models. *Journal of Experimental Child Psychology*, 77, 89–109. doi:10.1006/jecp.2000.2589.

Elina, M. A., andJulia, L. E. (2005). Determinants of Word Recall Performance on Verbal Working Memory Span Tasks in Children With SLI. *Journal of Speech Language and Hearing Research,* 48(4), 897-909. doi.org/10.1044/1092-4388(2005/062).

Hitch, G. J., andHalliday, M. S. (1983). Working memory in children.*Royal Society,* 302.doi.org/10.1098/rstb.1983.0058.

Ivanilde, A. V., Priscila, M. C., Elizeu, C. M., and Katerina, L. (2010). Working memory in children assessed by the Brown-Peterson Task. *Comparative Study,* 22(2). 95-100 DOI: 10.1590/s0104-56872010000200005.

Iyer, K. G., and Venkatesan.S. (2021). Working Memory Against Neuropsychological And Behavioral Profiles in Children with Neurodevelopmental Disorders. https://www.researchgate.net/publication/352965704.

Johan, E., Edward, K. V.,Anders, L., Fredrik, B., and Lars, N. (2015). Neurocognitive architecture of working memory**.** *Neuron*, 88(1)**,** 33–46. doi: 10.1016/j.neuron.2015.09.020.

Joni, H. , Sally, B., Francesca, C., Anita, V. L., Leanne, R., Linda, K., and Susan, G. (2015). Improving working memory in children with low language abilities. *Frontiers in Psychology,* 6, 519. doi: 10.3389/fpsyg.2015.00519.

Kamalam, G. I., and Venkatesan, S. (2021). Working Memory in Bilateral Versus Trilingual Children from Urban High Socialechonomic Indian Families. *Language in India,* 21(8). http;//languageininindia.com/aug2021/iyerworkingmemorybilingualurbaninchildrenfinal.pdf.

Keith A. W. (2018).The Role of Working Memory and its Importance to Everyday Life. https://www.kemin.com/na/en-us/blog/human-nutrition/the-role-of-working memory -and-its-importance-to-everyday-life.

Mark, D.E., and Bradley, R. P. (2014). The Cognitive Neuroscience of Working Memory. *Annual Review of Psychology*, 66, 115-142. doi: 10.1146/annurev-psych-010814-015031.

Mansi, S. R., Keerti, S., and Prashanth, P. (2020). Assessment of auditory working memory in children with abacus training. *European Archives of Oto-Rhino-Laryngology,* 277(5), 1531- 1536.doi: 10.1007/s00405-020-05840-z.

Morris, J.C., Allison, M.M. ., Melanie, V. B.,Cynthia, A.R., andHall (1999). Verbal Fluency in Children: Developmental Issues and Differential Validity in Distinguishing Children with Attention-Deficit Hyperactivity Disorder and Two Subtypes of Dyslexia. *Archives of Clinical Neuropsychology,* 14, 433-443. doi.org/10.1016/S0887-6177(98)00038-9.

Maria, C.P., and Hiwet, M.C. (2014). Working memory and early numeracy training in preschool children. *child Neuropsychology,* 22(1). 81-98.doi: 10.1080/09297049.2014.971726.

Miyake, A., and Shah, P. (1999). Models of working memory.Mechanisms of active maintenance and executive control. *Cambridge University Press,* ISBN 0-521-58325-X.

Merriam, W. (1829). Working memory. *Merriam-Webster.com Dictionary*. www.merriam-webster.com /dictionary/working%20memory.

Nelson, C. (2013). Working Memory Underpins Cognitive Development, Learning, and Education. *Educational Psychology Review,* 26,197–223. doi: 10.1007/s10648-013-9246-y.

Rhonda, M., Jill, H. C.S., Heilah, H. J., and Rosemary, T. (2005).A Meta-Analysis of Working Memory Impairments in Children With Attention-Deficit/Hyperactivity Disorder. *Journal of the American Academy of Child & Adolescent Psychiatry,* 44(4), 377-384. doi.org/10.1097/01.chi.0000153228.72591.73.

Randy, K. (2015). What Is Verbal Working Memory. *South county child and family* https://southcountychildandfamily.com/2015/10/29/what-is-verbal-working-memory/.

Susan, E.G., Tracy, P. A., Catherine,W., and Anne-Marie, A. (2006).Working memory in children with reading disabilities. *Journal of Experimental Child Psychology*, 93(3), 265-281. doi.org/10.1016/j.jecp.2005.08.003.

Solveig, J., Anke, B., Joseph, A. S.,and Erik, J.A.S. (2005).The impact of specific language impairment on working memory in children with ADHD combined subtype. Archives of Clinical Neuropsychology, 20(4),443-456. doi.org/10.1016 /j.acn.2004.10.004.

Susan, N., Amanda C. T., Keri, E. L., and Joanna, H. L. (2017). Verbal Working Memory in Children With Cochlear Implants. *Journal of Speech, Language, and Hearing Research Research*, 60(11), 3342-3364. doi.org/10.1044/2017_JSLHR-H-16-0474.

Satu, K., Anna, N., Petriina, M., Annarilla, A., Jaakko, M., Tapio, K., Riitta, P., and Leena, H. (2016). Working memory in very-low birthweight children at the age of 11years.*Child Neuropsychology*, 24(3), 338-353. doi:10.1080/09297049. 2016.1260101.

Steven, C. S., and Maryellen, C. M. (2020). Verbal Working Memory as Emergent from Language Comprehension and Production. *Frontiers in Human Neuroscience*, https://doi.org/10.3389/fnhum.2020.00068.

Sushma, K., and Susmita, H. (2018). Working memory, Verbal comprehension, Perceptual reasoning and Processing speed in ADHD and Normal children: A comparative study. *Journal of Association for Child and Adolescent Mental Health*, 14(1). https://www.researchgate.net/publication/324312511_Working_memory_Verbal_comprehension_Perceptual_reasoning_and_Processing_speed_in_ADHD_and_Normal_children_A_comparative_study.

Seija, P., Mira, G., Jungmoon, H., Loraine, K. O., Timo, E., and Martin, L. A. (2009). Semantic Verbal Fluency in Two Contrasting Language. *Clinical Linguistics and Phonetics*, 23(6), 431- 445. doi: 10.1080/02699200902839800.

Troyer, A.K. (2000). Normative data for clustering and switching on verbal fluency tasks. *Journal of Cinical and Experimental Neuropsychology*, 22(3), 370-8 doi:10.1076/ 1380-3395(200006)22:3;1-V;FT370.

Virve,V., Synnove,C., Anna-Maria,T., Tuija, F., Petteri, S., Suvi, S., and Eeva, T. A. (2012). Working Memory, Attention, Inhibition, and Their Relation to Adaptive Functioning and Behavioral/Emotional Symptoms in School-Aged Children. *Child Psychiatry and Human Development*, 44, 105-122.

Williams, D. L., Goldstein, G., and Minshew, N. J. (2006). The profile of memory functionin children with autism. *Neuropsychology*, *20*(1), 21–29. doi.org/10.1037/0894-4105.20.1.21.

Wendy, B. B. (2020). What Can Verbal Memory Help Us Remember? https://www.betterhelp.com/advice/memory/what-can-verbal-memory-help-us-remember/.

Wen, J. C., Aini, I. A .H., and Jafri, M. A. (2018). Working Memory From the Psychological and Neurosciences Perspectives. *Frontiers in Human Nuro science.* doi.org/10.3389/fpsyg.2018.00401.

Zahra, S., Meysam, A., Hooshang, D., and Shohre, S., (2014). Working memory in Farsi-speaking children with normal development and cochlear implant. *International Journal of Pediatric Otorhinolaryngology*, 78(4), 674-8. DOI: 10.1016/j.ijporl. 2014.01.035.

Zala.,Rameshwari., Sharma and Anil. (2021). Noncomputerised Circadian Interventions for Improving Working Memory Performance among Children. *Journal of Clinical and Diagnostic Research*, 15 (6), 1-6.